APPENDIX V

Infinite Slope Analysis for Cohesionless Soils

1. Infinite Slope Computations. For cohesionless materials ($c = 0$), equations applicable to an infinite slope may be used to obtain an estimate of the stability of the slope of an embankment where seepage is involved. It is assumed that the seepage flow is uniform throughout the soil mass.

2. General Case. The safety factor for the general case where seepage flow is neither parallel nor horizontal to the outer slope is

$$F.S. = \frac{\gamma' - (\gamma_w \frac{\tan \alpha}{\cot \beta})}{\gamma_{sat}} \cot \beta \tan \phi$$

where

γ' = submerged unit weight of soil

γ_w = unit weight of water

α = angle between seepage flow line and embankment slope

β = angle of inclination of embankment slope with horizontal ($\cot \beta = b$)

γ_{sat} = saturated unit weight of soil

ϕ = angle of internal friction

3. Seepage Parallel to Slope. For seepage flow parallel to and coincident with the embankment slope ($\alpha = 0$), the safety factor becomes

$$F.S. = \frac{\gamma'}{\gamma_{sat}} \cot \beta \tan \phi = \frac{\gamma'}{\gamma_{sat}} b \tan \phi$$

where

$b = \cot \beta$

4. Horizontal Seepage. Where seepage flow is horizontal ($\alpha = \beta$), the factor of safety is

$$F.S. = \frac{\gamma' - \frac{\gamma_w}{\cot^2 \beta}}{\gamma_{sat}} (\cot \beta \tan \phi) = \frac{b^2 \gamma' - \gamma_w}{b \gamma_{sat}} (\tan \phi)$$

5. No Seepage. Where no seepage forces exist, i.e. for a dry slope, the factor of safety is

$$F.S. = \frac{\tan \phi}{\tan \beta} = b \tan \phi$$

6. Earthquake. The effects of an earthquake loading can be applied to all of the previous equations for factor of safety by replacing b with the term b' where

$$b' = \frac{b - \psi}{1 + b_{\psi}}$$

ψ = seismic coefficient (see fig. 6, main text)

7. Example. An example of the influence of the direction of seepage flow on the factor of safety is illustrated in the following tabulation.

Assumed design values	Factor of safety for: Seepage parallel to outer slope	Horizontal seepage	No seepage
$b = 3.5$			
$\gamma_{sat} = 2\gamma_w$	1.23†	1.13†	2.45†
$\tan \phi = 0.7$			
$\psi = 0.1$	0.88††	0.74††	1.76††
$b' = 2.52$			

† Without earthquake loading.
†† With earthquake loading.